§21. Development of Multi-antenna RF Ion Source

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1. Introduction

As a filament less system, RF ion sources have several advantages, such as easy maintenance, long operation time, less contamination from the filament metals etc. However, high beam current and large diameter beam are necessary to be developed for the practical use as NBI source. We have been developing the multi-antenna RF ion source for these purposes. The dependences of antenna configurations and frequency on the plasma characteristics in the hydrogen negative ion source were studied [1].

2. Multi-antenna RF ion source

Conventional RF sources are using many turns coil as an antenna. This type of antenna makes extreme high voltage due to the large inductance when this antenna configuration is applied to the large size ion source, and the voltage limits the available RF power and also plasma density produced. In order to make the large ion source, the multi-antenna system is designed to reduce the antenna inductance and to increase the maximum RF power input on the antenna. The antenna elements are made of copper rods and placed in ceramic pipes to avoid taking plasma current and raising the plasma potential as a result. Eight antennas are installed in 35cmx35cmx18cm rectangular bucket source chamber and are connected electrically in two ways outside the vacuum as shown in Fig. 1. The RF of maximum power 2kW and frequency 9-14MHz is applied on the antennas and the ion saturation current I_{ion} is measured by Langmuir probe. Figure 2 shows that I_{ion} in plasma produced by 2-pararel antenna (Fig.1(c)) is larger than that by 4-parallel antenna (Fig.1(b)) below 2kW and also higher frequency operation tends to have lager I_{ion}. This tendency is attributed to the electrostatic discharge rather than inductive one in the low RF power range. However, the dependence of I_{ion} on Prf is strong for the 4-parallel antenna. Plasma production by 9MHz is larger I_{ion} than that of 2-parallel antenna with 14MHz in higher power region >2kW.

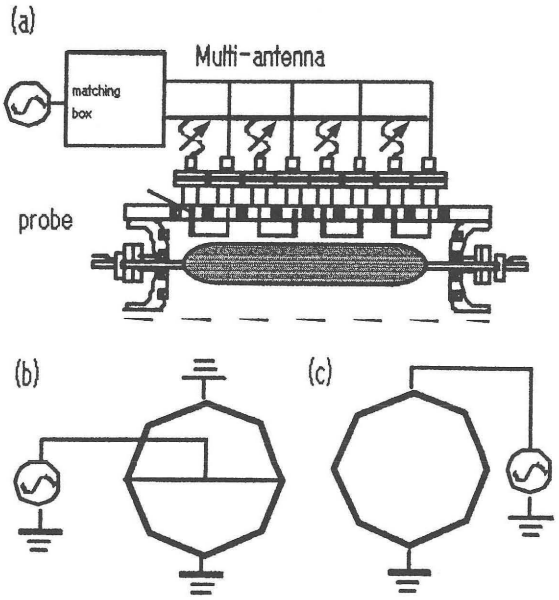

Fig. 1 (a) Multi-antenna RF ion source (8 segmented antennas) (b) 4 parallel antenna and (c) 2 parallel antenna systems.

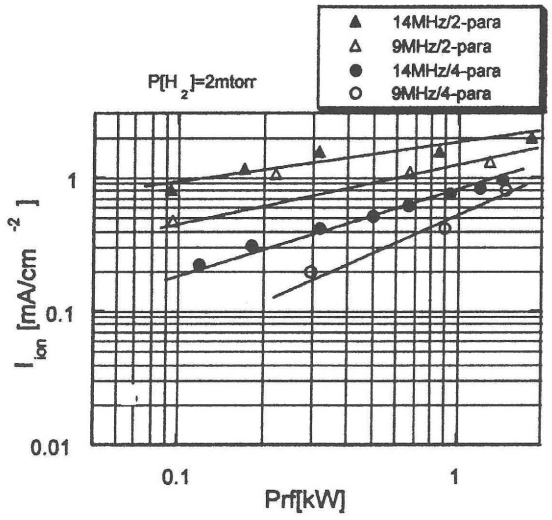

Fig. 2 Ion saturation current at the center of antenna loop as a function of RF input power for 2and 4 parallel antenna systems. RF frequency is 9-14MHz, hydrogen pressure is 2mtorr.

Reference:

1) in 5th Joint JA-EU Workshop on Neutral Beam Injectors 'Super CCNB', CIEMAT, Madrid, Sept. 2000